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CARL L. ALSBERG, Chief

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A CHEMICAL STUDY OF THE RIPENING AND PICKLING OF CALIFORNIA OLIVES.

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OLIVE CULTURE IN CALIFORNIA.

With the single exception of Arizona, olive culture in this country is limited to California, where the tree was introduced in the early days by Spanish priests, the first grove being planted in San Diego in 1769.[2] This origin is recorded in the name of what is to-day the most popular variety, the Mission olive, a descendant of the early plantings. The culture of the olive has extended until there are trees in 38 counties, the important counties being Riverside, Tulare, Tehama, Los Angeles, Butte, Fresno, San Bernardino, and Shasta. In the spring of 1916 a State census showed 834,939 bearing and 515,221 nonbearing trees.[2] In general, the olive-growing sections may be roughly grouped into three districts. The northern district, in the Sacramento Valley, centers in Butte County, with some groves as far south as Sacramento, and many fresh plantings in southern Shasta County, the farthest north. This district is one of the most important, and contains an enormous number of trees not yet bearing. The central district is in the San Joaquin Valley, principally in

[1] The authors wish to acknowledge their indebtedness to V. B. Bonney for a portion of the analytical work done in 1916, and to W. W. Karnan for a part of that conducted in 1914.

[2] Ann. Rept. Calif. Development Board for 1916. San Francisco, 1917.

Tulare and Fresno counties, centering at Lindsay and Fresno. Recently some very extensive planting has been done in Tulare County. The southern district lies in the territory centering around Los Angeles and San Diego. Although the oldest, it is, or soon will be, surpassed in production by both of the other districts. There are some groves also in a few sheltered valleys along the southern coast, and elsewhere, but they have little commercial importance. Planting is being done in the Imperial Valley. In 1916 the State's estimated yearly production was 1,000,000 gallons of olive oil and 300,000 6-gallon cases of pickled olives.[1] The rapidly growing popularity of the pickled ripe olives and the protection afforded to olive oil by food legislation have given a great impetus to the industry.

VARIETIES OF THE OLIVE GROWN IN CALIFORNIA.

The varieties of olives that have been grown in California are very numerous. The California Agricultural Experiment Station has reported analyses of 57 varieties.[2] The important ones, however, are limited in number, the favorite varieties being, in approximate order of importance, the Mission, Manzanillo, Ascolano, Sevillano, and Nevadillo Blanco.[3] Since the Nevadillo Blanco is more important as an oil olive than for pickling, the observations reported in this bulletin have been limited to the first four named. The Oblitza olive, a large Dalmatian variety, is also used for pickling. The olive was originally grown largely for oil, but more recently the pickling varieties have been in greater demand. The following descriptions of the five varieties are based in part upon material recognized by the industry under the respective names and in part on publications of the University of California.[4]

Mission.—This name denotes the variety derived from the old mission groves, and possibly covers several subvarieties. Of these the common or broad-leaved Mission is the one generally known as Mission. The fruit is of medium to large size, about ten-sixteenths to twelve-sixteenths inch in diameter; ovate, oblique—sometimes very much so—tip rather pointed; fruit variable in size; pit straight or somewhat curved, usually with a sharp point. (Pl. I.)

Manzanillo.—This variety was imported from Spain. It is a medium to large-sized olive, about the same as the Mission, approximately ten-sixteenths to twelve-sixteenths inch in diameter; quite regular, rounded oval, more nearly globular than the Mission, and

[1] Ann. Rept. Calif. Development Board for 1916. San Francisco, 1917.

[2] Rept. of Work of Agr. Exp. Sta., Univ. Calif., 1898–1901, pp. 263–307. Sacramento, 1902.

[3] E. J. Wickson. The California Fruits and How to Grow Them, pp. 335–350. San Francisco, 1914.

[4] Rept. of Work of Agr. Exp. Sta., Univ. Calif., 1898–1901. Acknowledgments are due F. T. Bioletti for reviewing these descriptions.

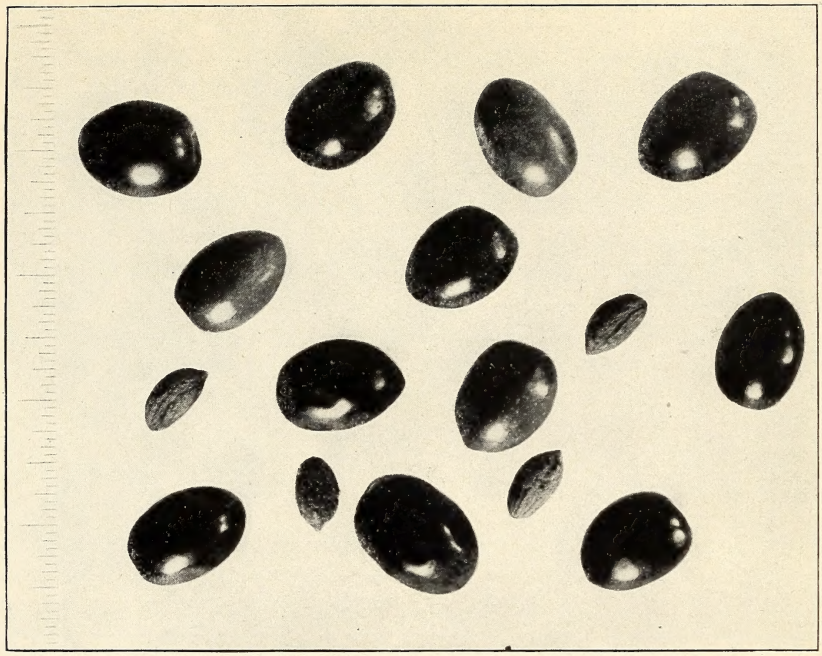


FIG. 1.—MISSION OLIVES, FRESH.

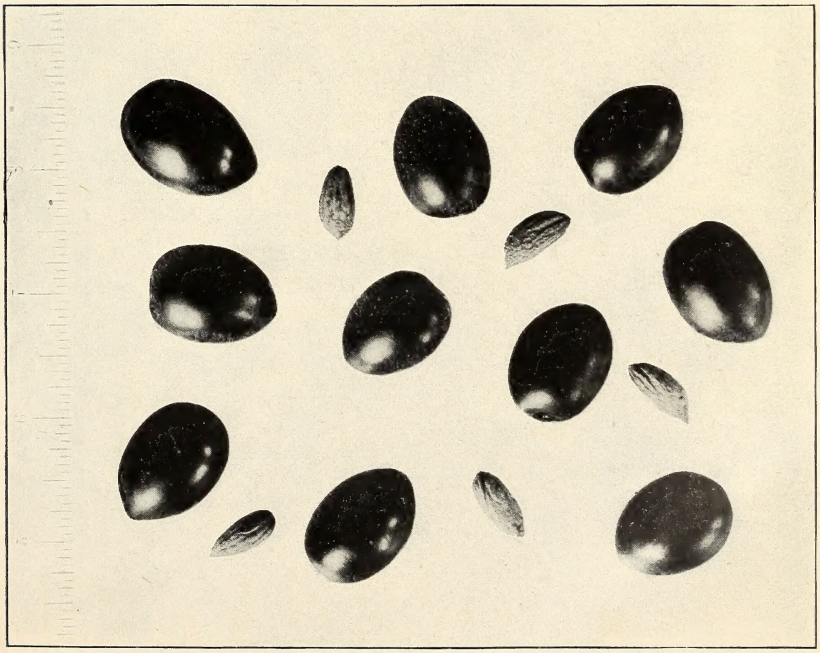


FIG. 2.—MISSION OLIVES, PICKLED.

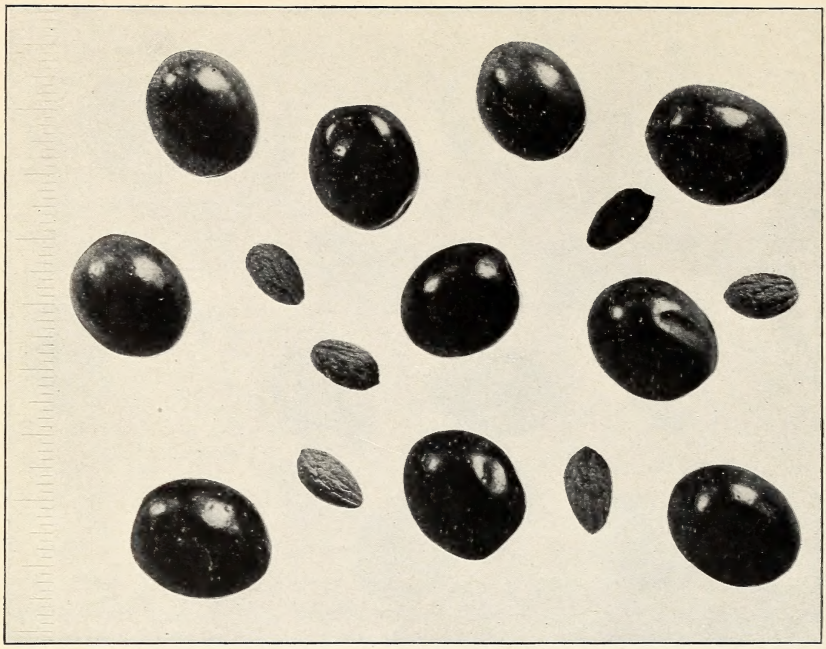


FIG. 1.—MANZANILLO OLIVES, FRESH.

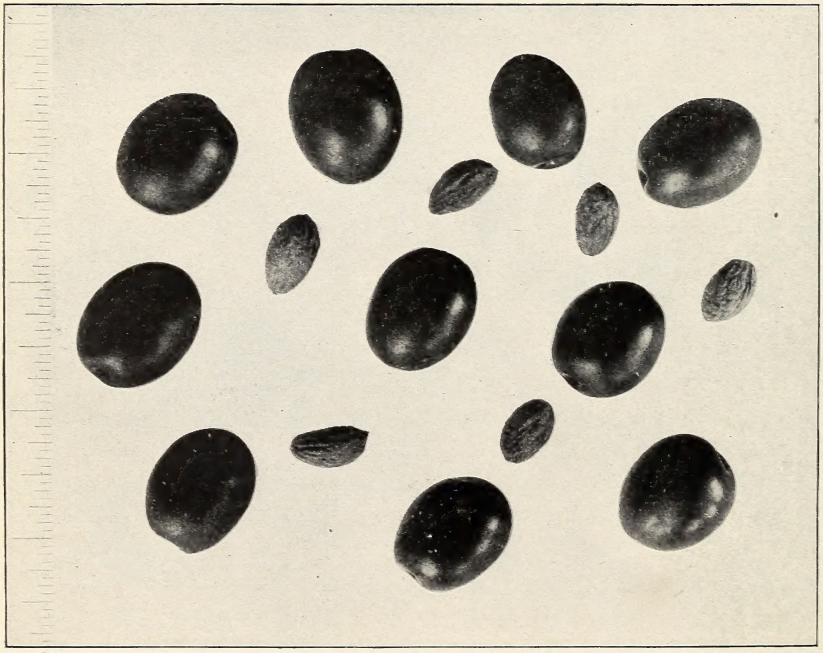


FIG. 2.—MANZANILLO OLIVES, PICKLED.

more rounded on the outer end, and with little indication of a point; pit straight, shorter than the Mission, and with the greatest diameter nearer the apex, often with a short, sharp point at the apex. (Pl. II.)

Ascolano.—This is a very large olive, twelve-sixteenths to eighteen-sixteenths inch in diameter; shape a rounded oval with some indication of a point, resembling an exaggerated Manzanillo; very soft and tender when ripe; pit with a short, sharp point at the apex. (Pl. III.)

Sevillano.—This is also a very large fruit, the largest of the Spanish varieties, and supposed to represent the one exported from Spain as "Queen" olives, from fourteen-sixteenths to eighteen-sixteenths inch in diameter; shape ovate, oblique, resembling a large Mission; very soft and tender when ripe; pit pointed and exceedingly rough, and sometimes with very sharp-pointed projections along its sides. (Pl. IV.)

Nevadillo Blanco.—This variety is small to medium in size, from eight-sixteenths to eleven-sixteenths inch in diameter; relatively long compared to diameter; pit comparatively large, quite curved, distinct veins on surface, and with a short, sharp point at apex.

The size statements in these descriptions refer only to the average run on the tree. Commercially all olives are separated into grades of different sizes.

OLIVE-PICKING SEASON.

The picking season for the olive varies greatly. It is influenced somewhat by variety, but more by locality. In the warm inland valley of the northern district the fruit matures earlier than in the southern portion of the State. The Manzanillo matures somewhat earlier than the Mission. In Butte County, in the northern district, Manzanillos are often picked about the middle of October, Missions late in October or about the first of November, and all varieties are gathered by January 1. In fact, there is danger from frost during December. In the southern district Manzanillos may be picked about November 1 and Missions about November 10. Ascolanos are picked about November 1. All olives are off the trees by February 1 to 15. In some exposed places nearer the coast the seasons may be still later.

CHANGES IN COMPOSITION DURING RIPENING.

Any study of the ripening of the olive must be preceded by a consideration of its constituents. The following are known or have been reported:[1] Fixed oil, protein, mineral matter, mannit (in the immature fruit only), an oxidizing enzyme acting on the oil, the enzyme emulsine and a glucoside "oleuropein," wax, reducing sugar probably dextrose.[2] De Luca [3] and others [2] claim to have iso-

[1] C. Wehmer. Die Pflanzenstoffe, p. 600. Jena, 1911.
[2] Arch. Pharm. (1902), vol. 240, p. 475.
[3] Rend. accad. sci. Napoli (1865), p. 79.

lated mannit from the immature olives, but more recently Hartwich and Uhlmann[1] declared that its presence had not been conclusively shown, and stated that they could not detect it. These authors, who followed microscopically the development from bud to fruit, state that there is no starch in the olive at any stage, with the exception of cells adjoining the stomata. These writers also reported that glucose was present in almost all stages of development, and they believed it to be the substance from which the oil is formed. Of interest is the glucoside discovered by Bourquelot and Vintilesco[2] and named by them "oleuropein." Subsequently[3] they isolated it in a state of comparative purity, finding it powerfully levorotatory and yielding *d*-glucose on hydrolysis by dilute acid or emulsine. They reported it as possessing a strongly bitter taste, which is of special interest, since it thus appears probable that this is the substance, or at least one of the substances, which gives to fresh olives, both in their green and ripe state, their intensely bitter flavor, making it impossible to eat them until the bitter principle has been removed by the pickling process. Also Bourquelot and Vintilesco,[4] by the use of invertine, claim to have demonstrated the probable presence of very small amounts of sucrose in the olive.

A number of studies on the ripening of the olive in Europe are given in the literature on this subject. De Luca seems to have been the first investigator,[5] beginning in 1861. He showed the increase in the volume and weight of the fruit and that the oil increased gradually from the time the pit was formed. In 1878, Roussille[6] published analyses following the ripening and showing an increase of oil in the fruit flesh from about 1 per cent in July to 34 per cent at the end of November. Funaro published similar analyses,[7] tracing the oil in the fruit flesh from a very low figure in the latter part of July to 27 per cent in late February. Hartwich and Uhlmann, studying fruit from San Remo,[1] distinguished three periods of development. In the first, covering approximately July and August, the pit was forming, and the oil content, on a basis of the whole fruit, increased from about 0.5 per cent to 5 per cent. In the second period, September and October, the pit increased little, while the flesh and oil increased rapidly. In the third period, from October to January, the oil increased slowly until there was 30 per cent in the fruit flesh, which finally declined to nearly 25 per cent in the middle of February. De Luca had noted a similar decrease in oil at the end of the

[1] Arch. Pharm. (1902), vol. 240, p. 475.
[2] J. pharm. chim. (6th ser.) (1908), vol. 28, p. 303. Compt rend. (1908), vol. 147, p. 533.
[3] J. pharm. chim. (7th ser.) (1910), vol. 1, p. 292.
[4] J. pharm. chim. (6th ser.) (1908), vol. 28, p. 303 (7th ser.) (1910), vol. 1, p. 292.
[5] Rend. accad. sci. Napoli, for 1861 and following years (original source not available).
[6] Compt. rend. (1878), vol. 86, p. 610.
[7] Landw. Vers-Sta. (1880), vol. 25, p. 52.

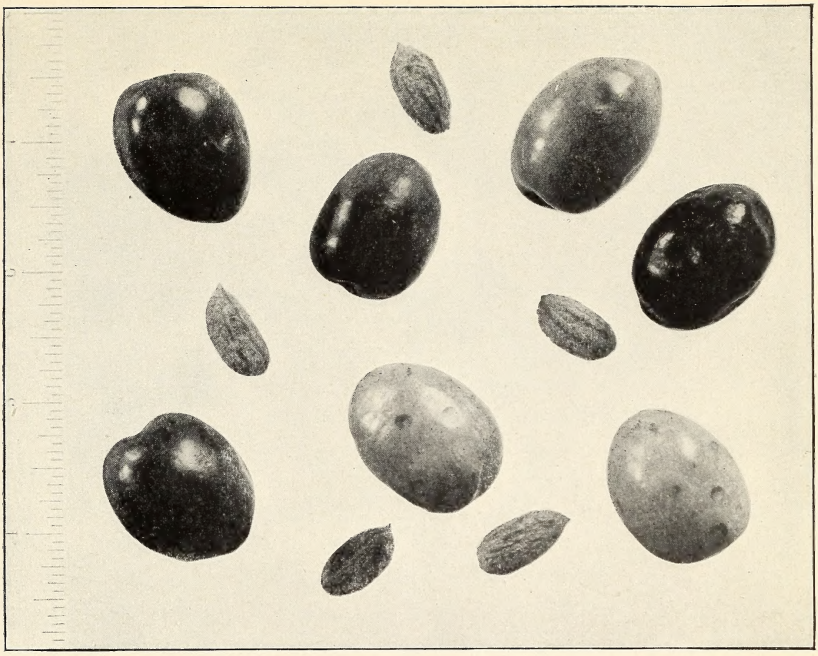


FIG. 1.—ASCOLANO OLIVES, FRESH, RIPE (SOFT IN SPOTS).

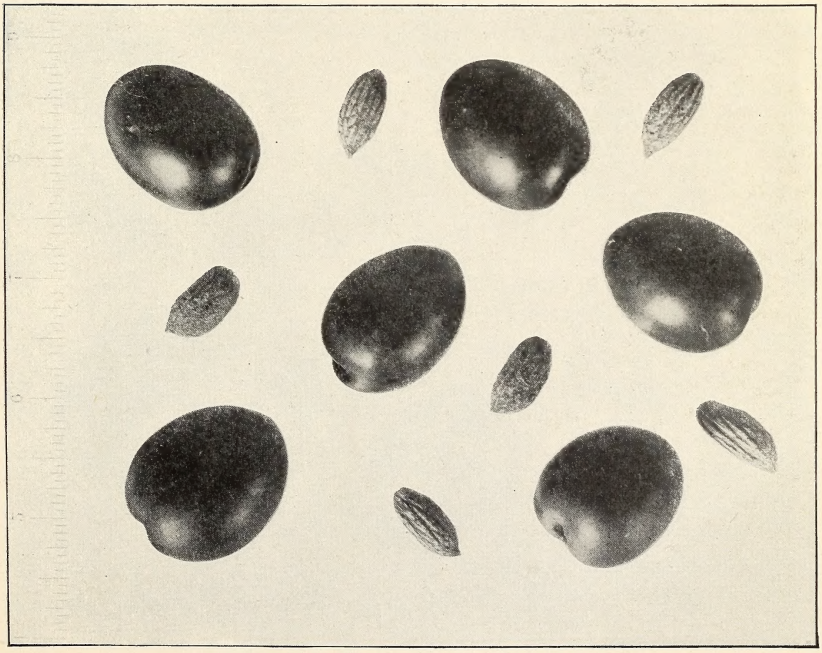
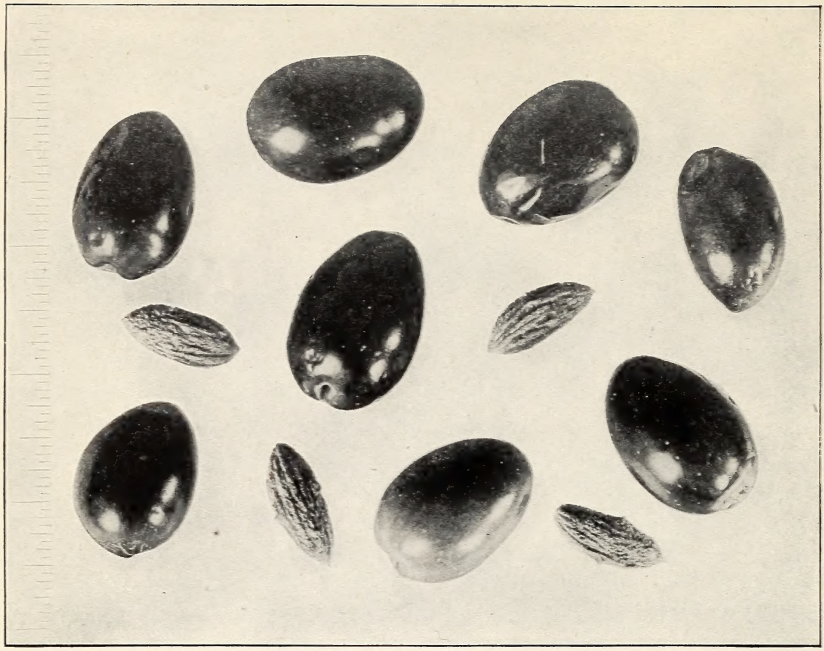
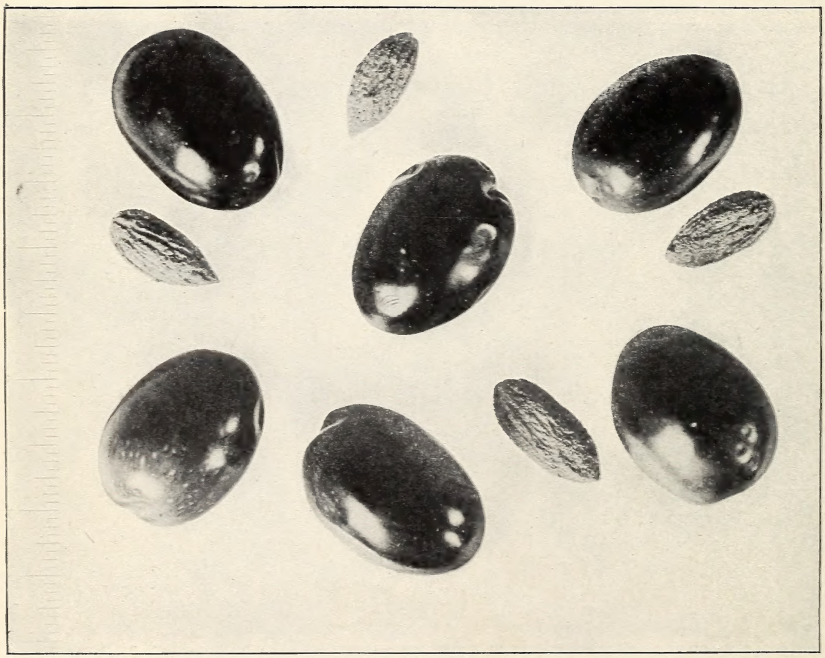


FIG. 2.—ASCOLANO OLIVES, PICKLED.





SEVILLANO OLIVES, FRESH (RIPE AND SOFT).

season. Altogether it is evident that the increase in oil is the striking feature in the development of the fruit.

THE PICKLING OF OLIVES.

There are two methods for rendering edible the fruit of the olive tree, only one of which is commercially valuable. By allowing the olives to soak in brine or fresh water, which is frequently changed, for from 6 weeks to 2 months, the bitter principle is decomposed or removed, and a very palatable article is produced. This method, however, consumes too much time, and the losses due to mold and softening of the fruit bar its general use on a large scale.

Although there are, of course, minor differences in various plants, the general commercial method of pickling ripe olives is as follows: The olives are picked by hand. The buyer gives instructions to the pickers as to the color desired, which varies from "yellow" to red or tinges of red. Usually at least three pickings are necessary to obtain the maximum amount of olives of the desired color. Sometimes the fruit is sent 500 miles to the factory, as from Butte County to San Diego. Such long shipments are made in barrels or wooden vats, the fruit being covered with a weak brine to which is sometimes added a small amount of caustic soda, about one-fourth pound to the gallon.

In the factory the first operation is grading to size, for which purpose several machines have been designed. The most common type of grader consists of a series of vibrating screens with circular holes of gradually increasing size. This gives grades of three or four sizes, the olives smaller than nine-sixteenths inch being generally used for oil. In another common modification the screen bottoms are made of narrow tin strips, the distances between which correspond to the diameter of the holes in the other machine. Both of these machines tend to bruise the fruit somewhat. To avoid such bruising another very simple and satisfactory machine, consisting of a series of rubber-covered rolls which are set at slight angles to each other and inclined, is used. The opening between the rolls is smallest at the top of the incline, and largest at the bottom. The rolls rotate in pairs in opposite directions, so that the inside surfaces turn upward. The olive rolls down the incline, and there is no tendency to mash the olive or bruise it by sudden contact with any sharp edges. When the opening between the rolls becomes greater than the short diameter of the olive it drops through into boxes below, according to its size. The size graduations are usually made on the basis of a difference of about two-sixteenths inch in diameter. There are no recognized trade standards for the size grades or for their commercial designations. Each packer has his

own system. The standards in Table 1, based on the best commercial practice, have been suggested by Bioletti.[1]

TABLE 1.—*Standards for size grades.*

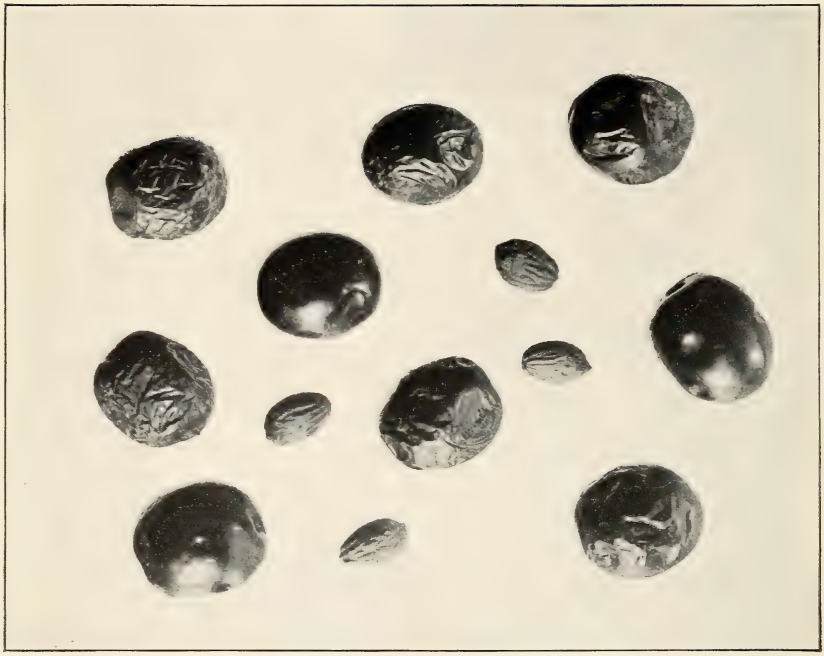
Designation.	Size.	Average diameter in sixteenths of an inch.	Average number per pound.			
			Mission.	Sevillano.	Ascolano.	Manzanillo.
Extra large	1	16	35	33	36	39
Large	2	14	52	49	54	58
Medium	3	12	82	78	86	93
Small	4	10	135	142	148	160
Extra small	5	Below 9	?	?	?	?

Many fancy names and symbols are used to designate the various grades. The graded olives are sometimes run over sorting belts to be segregated for color, but this is not common.

After being graded and sorted, the olives are taken to the pickling vats. In the newer factories, these are made of concrete, about 8 by 3 by 2 feet. Similar tanks of redwood are also used, and sometimes circular tanks of redwood, about 8 feet in diameter and from 4 to 5 feet deep. Subject to some variation, the following treatment is applied: A quantity of 1½ to 2 per cent caustic soda solution, in weight about five times that of the olives, is poured over the fruit, and allowed to stand for from 6 to 8 hours, with frequent stirring. This liquor is then drained off, and the olives exposed to the air for 24 hours, with occasional stirring. More of the same or a weaker solution is applied for a similar length of time, and again run off and the fruit aerated. This operation is performed a third time, or until the caustic reaches the pit, as indicated by a darkening of the flesh. The lye solution is then run off, and fresh water added to the vat. The water is changed about every 12 hours until all the lye is washed out. The pickler determines this by taste. Tests of all commercial samples analyzed, with phenolphthalein, show the absence of free alkali or normal carbonates. At this point, salting of the olives is begun by soaking them in solutions of brine of gradually increasing strengths, of about 1, 2, and 4 per cent of salt. Factory control is by means of the salometer, a hydrometer graduated in hundredths from zero in distilled water to 100 in saturated salt solution. Usually the strongest solution employed is approximately 15° on this scale. The olives are soaked about 2 days in each of these different solutions, after which they are canned in a 3 or 4 per cent brine and processed in a water bath. Recently Bioletti and Cruess have proposed preserving in lacquered cans or glass jars without any liquid.[2] It is claimed that the olives thus treated keep their black color better than when brine is used.

[1] Calif. Agr. Exp. Sta. Bul. 263. The California Olive Association recently has adopted a set of size standards.

[2] Calif. Agr. Exp. Sta. Bul. 289.



MANZANILLO OLIVES, FRESH (ILLUSTRATING THE SHRIVELING DUE TO FROST).

In most factories, after salting, the olives are run over sorting belts, where they are sorted into two or three color grades, and all bruised or injured fruit removed before canning. Patents for assignment to the public have been applied for by Bioletti and Cruess of the California Agricultural Experiment Station at Berkeley, for improvements in olive pickling, which involve the use of heated solutions, with aeration and constant circulation of the solutions.[1] These conditions are obtained in various ways, and it is claimed that the time required is very much shorter, and that a more satisfactory product is obtained. Further details can be had from their descriptions. A point of special interest in pickling the black or ripe olives is that the black color is formed or set by aeration accompanying the alkali treatment.

The pickling of green olives for sale as such is very similar. The olives are picked before any yellow color shows, and they are treated with similar solutions, except that usually only two caustic solutions are used, and the greatest care is taken to protect the olives from exposure to the air, which tends to cause a darkening of the color. The green olive is given an after fermentation under 7 per cent brine which develops its peculiar piquancy.

PURPOSE OF INVESTIGATION.

During the summer and fall of 1914 complaints concerning the pickling of ripe olives in California were received by the Bureau of Chemistry. The charge was made by one or two of the firms engaged in this business that it was becoming a very common practice among the picklers of olives to gather the fruit in a green and immature state and so to manipulate it during the pickling that the color was artificially and unnaturally changed from green to black, the finished product being sold as a ripe olive, to the deception of the consumer and the detriment of the industry. The advantages of this alleged fraudulent practice were stated to be that the fruit could be stripped from the trees in one or, at the most, two pickings, whereas if it were left until it had reached a proper stage of ripeness several pickings would be necessary; also that hard, immature fruit requires less care and skill in pickling, and that early picking does away with the danger of frost damage, especially in the northern districts. It was evident that if there were truth in this statement the practice in question would amount to a coloring or staining by which the inferiority of the immature fruit would be concealed, and that it would be analogous to the coloring of immature oranges by sweating. On examination the question seemed to merit careful study. The investigation here reported was accordingly undertaken to determine whether immature olives were being pickled and sold as ripe, and also whether inferiority was being concealed by a process of coloring.

[1] Calif. Agr. Exp. Sta. Bull. 289.

PLAN OF INVESTIGATION.

As it does not appear that any systematic study has been made of the ripening of olives in California, the plan of this investigation was first to follow the development of the fruit on marked trees, recording changes of composition and physical characteristics, especially color, in order to establish, if possible, the differences between immature and ripe fruit, and to ascertain how closely the color of the fresh fruit is related to or may indicate maturity. This was done for different varieties and localities, and during successive seasons to show the influence of these factors. In the second place, to make the data applicable to the finished product, different lots of olives were followed through the pickling process to find what changes occur in the composition and color.

FIELD WORK ON FRESH FRUIT.

When the field work was taken up in 1914, the season was too far advanced to permit of any investigation of composition changes during growth. However, in the middle of December, when the fruit certainly could be considered mature in almost all localities and a large part of the picking was completed, series of samples of the most important varieties of olives were collected from the same or neighboring trees in localities in the northern and southern districts. They were analyzed both to afford data on mature fruit and to show, if possible, the relation of color to composition. Also a number of pickling factories were inspected, and men prominent in the industry interviewed.

In the 1915 season the systematic study of the ripening was undertaken in the northern district. Trees of different varieties in different localities were marked and sampled at intervals of practically three weeks from September 15, when the fruit is well formed, to December 15. Since fresh olives are worth from 15 to 20 cents a pound, the value of one tree's crop is so great that no attempt was made to buy outright the whole crop of the trees under observation. As it was considered desirable to follow the development past the regular harvest time, arrangements were made with the growers to leave a certain portion of the tree untouched in the picking. Unfortunately, the picking is done by Japanese, Hindus, and Mexicans, and, in spite of the owners' efforts, many of the trees had been nearly stripped, or at least most of the highly colored fruit had been picked, at the last sampling period. In the northern district the grower generally assumes the frost risk up to December 10, and most of the picking is over by the middle of that month.

The plan of operations for the 1916 season was the same as for that of 1915, except that the trees were more numerous and were scattered over all the important olive districts.

METHODS OF EXAMINATION.

When received at the laboratory the olive samples were immediately examined for color, and, if analysis could not be begun without delay, they were sent to a cold-storage warehouse and stored at about 34° F. until wanted. A slight increase in color was sometimes evident after such storage.

The laboratory methods of examination, as finally adopted, were as follows:

PHYSICAL EXAMINATION.

Record the following: Color, flavor (if pickled), and ease of cleavage of the pulp from the pit; average short diameter in sixteenths of an inch, measuring 50 or 100 olives; number of olives per pound; percentage by weight of pits.

PREPARATION OF SAMPLES FOR CHEMICAL ANALYSIS.

If pickled, pour off the brine and dry the olives with a towel. Reserve the brine for determination of salt. Count out 1 pound of olives, recording the number. Remove the pits with a cherry pitter. Scrub the pits with a brush, dry with a towel, and weigh moist, giving percentage of pits. Pass the flesh of the fruit twice through a meat grinder,[1] and receive in an evaporating dish. Weigh out samples immediately, stirring thoroughly with a spoon before removal of each portion. If desired to analyze the pits, air dry them in a warm place, weigh, and grind as fine as possible in a drug mill.

CHEMICAL ANALYSIS OF FLESH.

Solids.—Weigh out approximately 10 grams in a 2-inch lead capsule containing a teaspoonful of recently ignited sand and a short glass stirring rod. Mix intimately and dry in the water oven, which requires from 5 to 7 hours.

Ether extract.—The material in the lead capsule, including the stirring rod, is crushed and brushed into the inner tube of a Knorr fat extractor, prepared with an asbestos mat about $\frac{1}{8}$ inch thick, previously washed with alcohol and ether, and dried. Cut up the capsule and add to the tube. Extract for about 12 hours with anhydrous ether. Remove the inner tube, let the ether evaporate, grind up the contents in a mortar, return to the tube, and continue extraction for 4 hours longer. Dry the oil to constant weight in the water oven, avoiding undue heating. Periods of from $\frac{1}{2}$ to 1 hour are sufficient.

Protein ($N \times 6.25$).—Weigh out about 10 grams into a 9 cm. filter paper, folded into a cone and placed in a wide-mouth weighing bottle. Transfer the paper and sample to the Kjeldahl flask, and determine

[1] As the skin of the olive is rather tough, the grinder used must be provided with sharp cutting knives.

nitrogen by the Gunning method, using 40 to 50 cc. of acid, 10 grams of potassium sulphate, and a small crystal of copper sulphate.

Ash.—Burn a 10-gram sample in a flat-bottomed platinum dish at a moderate temperature. If necessary to get a clean ash, cool, moisten with water, evaporate, and ignite again, repeating until the carbon is gone.

Alkalinity of ash.—Add 25 cc. of N/10 sulphuric acid to the ash in the dish, heat under a watch glass for a few minutes, and titrate back with N/10 caustic soda, using methyl orange.

Salt-free ash.—In pickled olives, make the solution up to 100 cc., filter, and titrate 25 cc. portions with N/10 silver nitrate and potassium chromate indicator. Express as salt, and calculate salt-free ash.

CHEMICAL ANALYSIS OF PITS.

Determine moisture, ether extract, nitrogen, and ash. For moisture dry 5 grams in a lead capsule, without sand, to constant weight in the water oven, which requires from four to five hours. Extract this residue with anhydrous ether in the Knorr apparatus. This is completed in from six to eight hours. Use 5-gram portions for nitrogen and ash determinations. Calculate the analysis back from the air-dry basis to that of the original moist pits as removed from the olives.

TABLE 2.—*Composition of fresh California olives.*[1]

Sample No.	Source.	Date of collection.	Color.	Whole fruit.													Flesh (water-free basis).			Number per pound.	Average diameter in sixteenths of an inch.
					Composition of flesh.							Composition of pits.									
				Flesh.	Solids.	Oil.	Protein (N x 6.25).	Ash.	Alkalinity No. of ash.[2]	Pits.	Solids.	Oil.	Protein (N x 6.25).	Ash.	Alkalinity No. of ash.[2]	Oil.	Protein (N x 6.25).	Ash.		
	MISSION.	1914.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.		P. ct.	P. ct.	P. ct.	P. ct.	P. ct.		P. ct.	P. ct.	P. ct.		
18205-K	Oroville	Dec. 8	Purple to black	84.0	41.7	24.89	1.55	1.66	8.1	16.0	75.72	2.90	2.62	0.469	11.39	59.7	3.74	3.99	96	12.0
18206-K	do	do	Red	82.3	45.8	27.35	1.73	1.72	11.9	17.7						59.7	3.74	3.76	128	10.8
18207-K	do	do	Yellowish green	80.0	36.0	20.37	1.27	2.20	7.3	20.0						56.5	3.54	6.11	125	11.0
18208-K	do	do	Green	77.8	40.2	23.55	1.74	1.70		22.2	76.31	3.30	2.70	.554	11.89	58.7	4.32	4.23	162	9.7
18574-K	Sylmar	Dec. 17	Black	85.8	42.8	25.95	1.45	1.88	11.1	14.2						60.6	3.39	4.39	95	11.6
18574-K	do	do	Red tinge	81.2	35.4	21.21	1.18	1.96	9.6	18.8						60.0	3.32	5.54	133	10.3
18577-K	La Mirada	do	Black	87.8	43.1	24.20	1.38	1.60	10.1	12.2	77.76	3.81	2.58	.487	7.35	56.1	3.19	3.71	99	11.4
18577-K	do	do	Green	84.0	34.8	20.68	1.65	1.42		16.0	75.94	3.51	2.56	.451	7.37	59.4	4.56	4.08	120	10.9
18579-K	Colton	Dec. 18	Black	87.2	46.6	27.05	1.53	2.11	8.4	12.8						58.8	3.13	4.53	120	10.7
18581-K	Highlands	do	Purple to black	88.1	38.0	23.05	1.94	1.82	6.5	11.9						60.6	5.10	4.79	86	11.6
18581-K	do	do	Green	80.8	32.6	18.40	1.66	1.75		19.2						56.5	5.09	5.37	173	10.2
18585-K	Hemet	do	Red	83.8	36.3	21.25	1.63	2.09		16.2						58.5	4.48	5.75	100	11.2
18586-K	Corona	Dec. 19	Purple to black	85.7	46.2	26.38	1.45	2.22	8.7	14.3						57.1	3.14	4.81	77	12.7
18589-K	Elsinore	do	do	84.3	45.9	29.15	1.59	1.75	9.2	15.7						63.5	3.50	3.82	83	12.1
18589-K	do	do	Red tinge	79.6	33.3	18.91	1.43	1.68	8.1	20.4						57.0	4.30	5.05	114	10.5
18592-K	Perris	do	Purple to black	87.6	44.5	26.67	1.63	1.84	8.8	12.4						60.0	3.64	4.13	76	12.2
	MANZANILLO.																			
18573-K	Sylmar	Dec. 17	Red to purple	88.2	31.1	18.34	1.60	1.72	9.0	11.8	73.05	2.96	2.38	.538	8.03	59.5	5.14	5.56	90	12.1
18573-K	do	do	Green	86.7	29.3	17.64	1.16	1.77		13.3	72.28	3.81	2.60	.531	8.93	60.0	3.98	6.05	117	10.9
18578-K	Colton	Dec. 18	Purple to black	88.7	41.1	25.65	1.17	1.92	8.1	11.3						62.5	2.86	4.80	81	11.5
18578-K	do	do	Green to red	88.4	31.2	20.20	1.13	1.63		11.6						64.8	3.62	5.20	96	11.6
18580-K	Redlands	do	Purple to black	89.9	35.7	23.07	1.34	1.64	7.85	10.1						64.7	3.76	4.60	83	11.6
18580-K	do	do	Green to red	86.2	29.4	16.80	1.30	1.69		13.8						57.2	4.43	5.75	144	11.3
18583-K	Moreno	do	Purple to black	90.5	33.3	19.93	1.45	1.81	7.2	9.5						60.0	4.36	5.44	80	10.5
18583-K	do	do	Green to red	87.2	30.0	17.92	1.13	1.79		12.8						59.7	3.75	5.97	137	10.7
18588-K	Elsinore	Dec. 19	Black	87.2	47.2	29.08	1.48	2.21	9.6	12.8						61.6	3.14	4.68	91	12.4
18588-K	do	do	Green	87.7	32.2	19.30	1.38	1.82	8.5	12.3						59.9	4.27	5.65	95	12.3

[1] Samples collected in fall of 1914, and analyses made in the San Francisco Food and Drug Inspection Station, by R. S. Hollingshead and W. W. Karnan.

[2] The "alkalinity number of ash" is defined as the number of cubic centimeters of normal acid required to neutralize 1 gram of ash (Buttenberg, Zeit. Nahr. Genussm, vol. 9, p. 142. 1905).

TABLE 2.—*Composition of fresh California olives*—Continued.

Sample No.	Source.	Date of collection.	Color.	Whole fruit.												Flesh (water-free basis).			Number per pound.	Average diameter in sixteenths of an inch.
					Composition of flesh.						Composition of pits.									
				Flesh.	Solids.	Oil.	Protein (N x 6.25).	Ash.	Alkalinity No. of ash.	Pits.	Solids.	Oil.	Protein (N x 6.25).	Ash.	Alkalinity No. of ash.	Oil.	Protein (N x 6.25).	Ash.		
	ASCOLANO.	1914																		
18582–K	Moreno	Dec. 18	Red	89.5	29.0	17.02	1.68	1.70	7.5	10.5	71.69	4.15	2.56	.556	6.51	58.6	5.76	5.86	41	15.4
18582–K	do	do	Green to red	90.4	25.8	15.15	1.21	1.56	.....	9.6	74.17	4.61	2.86	.592	7.65	58.7	4.70	6.05	46	14.7
18587–K	Corona	do	Black	88.9	46.8	29.27	1.82	2.15	9.7	11.1	.....	.....	.....	.....	.....	62.6	3.91	4.60	54	14.7
18587–K	do	do	Green	89.1	36.0	19.80	1.79	1.72	9.8	10.9	.....	.....	.....	.....	.....	55.0	4.97	4.78	50	15.0
18591–K	Perris	Dec. 19	Red to purple	89.1	41.2	24.79	1.79	1.87	9.7	10.9	.....	.....	.....	.....	.....	60.2	4.36	4.57	47	15.0
18591–K	do	do	Green	87.7	32.9	18.21	2.03	1.95	9.2	12.3	.....	.....	.....	.....	.....	55.4	6.18	5.93	62	13.0
	NEVADILLO.																			
18212–K	Oroville	Dec. 9	Black	81.6	37.4	23.04	1.98	2.06	8.8	18.4	.....	.....	.....	.....	.....	61.6	5.30	5.38	175	9.9
18575–K	Sylmar	Dec. 17	do	86.6	38.7	22.80	1.60	2.36	.....	13.4	72.55	3.65	2.93	.548	7.02	59.0	4.14	6.10	145	9.9
18575–K	do	do	Green	85.6	38.4	23.45	1.34	2.23	.....	14.4	72.89	3.89	2.77	.649	6.49	61.2	3.50	5.81	175	9.2
18593–K	Highlands	Dec. 19	Purple	86.6	42.9	24.90	1.99	2.32	8.03	13.4	.....	.....	.....	.....	.....	58.1	4.65	5.41	146	9.6
18594–K	Hemet	do	Yellowish green	82.7	30.7	17.38	1.54	1.97	7.4	17.3	.....	.....	.....	.....	.....	56.6	5.01	6.43	127	10.8
	COLUMBELLA.																			
18576–K	La Mirada	Dec. 17	Black	87.2	38.1	23.53	2.26	1.62	8.9	12.8	74.91	4.54	2.60	.555	6.66	61.8	5.94	4.25	114	10.7
18576–K	do	do	Green	85.5	31.7	18.97	1.81	1.52	8.0	14.5	74.23	4.22	2.61	.427	7.91	59.9	5.73	4.80	.....	.....
18590–K	Elsinore	Dec. 19	Red	83.5	43.3	28.64	2.03	1.69	8.4	16.5	.....	.....	.....	.....	.....	66.1	4.69	3.90	.....	.....
18590–K	do	do	Green	79.6	38.2	23.00	1.98	1.91	7.6	20.4	.....	.....	.....	.....	.....	60.3	5.16	5.00	.....	.....

RESULTS OF EXAMINATION OF FRESH OLIVES.

The data (Table 2) on the samples collected in December, 1914, at which time practically all olives should be ripe, are interesting. These samples, which were carefully selected and segregated on the color basis, ranged from green to purple. The first four samples in the table were picked from the same or adjacent trees in the same grove, as were all the other pairs of samples bearing the same sample number. Size is recorded as number of olives per pound and also in average short diameter in sixteenths of an inch, as both these methods of designation are used commercially. It may be mentioned that diameter and weight are not exactly related, owing principally to differences in shape. Four colors are distinguished—green, yellow, red, and purple. By green is meant "grass" green. The term "yellow," although commonly used by the grower, is a misnomer, as it is a yellowish green, which appears just before the first tinges of red. A study of the various sets of samples in Table 2 coming from the same trees or grove shows that the olives with the more advanced colors usually are larger and heavier than the others, that they have a lower percentage of pits, and, as a rule, are higher in solids in the fruit flesh and contain more oil in the flesh. The oil in the flesh on the dry basis does not appear to be related closely to the color, being frequently nearly the same for the purple and green olives and sometimes higher in the green sample. The amounts of protein and ash in the flesh are roughly equal, fairly uniform, and do not appear to bear any relation to color. The composition of the pits also bears no relation to the colors. In general, then, among olives from the same tree or grove, the ones with deeper

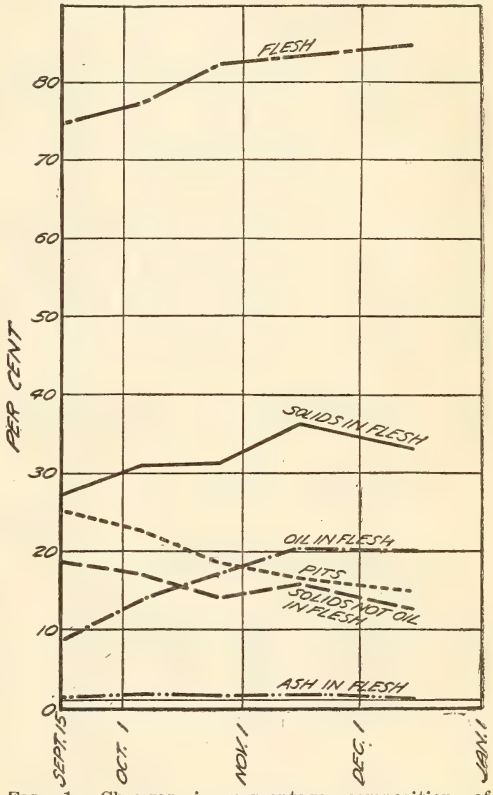


FIG. 1.—Changes in percentage composition of Mission olives occurring during ripening in 1915.

color are the largest and have the most oil and solids in the flesh. This does not hold, however, in comparing olives of the same variety from different groves or localities, as in several instances the green colored fruit has the more oil and solids in the flesh (Samples 18208 and 18581; 18582, 18587, and 18591; 18583 and 18588).

Since the complete data on the series of samples taken from marked trees during the seasons of 1915 and 1916, to show the progressive development of the fruit, are too voluminous to be given here, Table 3 has been compiled from the data secured for a single typical Mission tree in 1915. This table may be taken as an example of the progressive changes observed in the investigation. A clearer idea of the changes which occur during the course of ripening may be obtained from a graphic representation of the data from selected trees, first on the percentage basis, and then on the basis of actual weight changes. Figure 1 shows the percentage changes for a certain Mission tree in 1915, while figure 2 represents the absolute changes in weight of the constituents of 100 olives. The development is indicated by broken curves joining the successive samples from the tree. The same kind of a diagram has been made for a representative Mission tree in 1916 (figs. 3 and 4).

TABLE 3.—*Ripening changes of California olives (typical Mission tree, Butte County, 1915).*

Date.	Fruit flesh.				Number per pound.	Average diameter in sixteenths of an inch.	Pits.	Color.
	Solids.	Ether extract.	Protein (Nx6.25).	Ash.				
1915.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*			*Per cent.*	
Sept. 15....	28.58	7.62	1.73	1.76	240	8.5	32.6	Green.
Oct. 6.....	29.87	11.22	1.73	1.79	226	8.4	29.6	Do.
Oct. 28.....	32.42	15.46	1.36	1.81	199	8.7	26.4	Green, showing some yellow.
Nov. 15....	37.16	18.95	1.52	1.82	192	9.2	24.6	Mainly green; few yellow and red.
Dec. 15.....	37.43	21.38	1.28	1.80	181	8.8	24.0	Half, yellow with red; half, red to purple.

An examination of figures 1 and 3 shows that the percentage of pits falls as the fruit ripens, while, conversely, that of the flesh rises. The percentage of ash in the flesh remains approximately the same. This is true also of the protein, the representation of which, however, is not included in the charts for the reason that it would practically follow the line for the ash. The protein content was not determined in 1916, as it seemed to have but little significance. It is evident that the percentage of solids not oil in the flesh decreases somewhat during the ripening, the percentage of oil in the flesh increases, with some little irregularity, and appears to drop

slightly toward the end of the period in question, while the percentage of solids in the flesh increases with a drop toward the end. Figures 2 and 4, however, give a more truthful idea of the actual progress of the growth of the olive. It is here seen that the actual weight of the pits, which were fully formed at the earliest date, remains practically constant. The weight of ash in the flesh rises very slightly, while that of nonoil solids is very nearly constant, or rises somewhat. The weight of the oil increases markedly in the fore part of the period and slightly near the end, the weight of solids in the flesh following closely the course of the oil. The weight of the flesh and the total weight increase greatly during ripening, with some fluctuations for one of the trees, and follow each other.

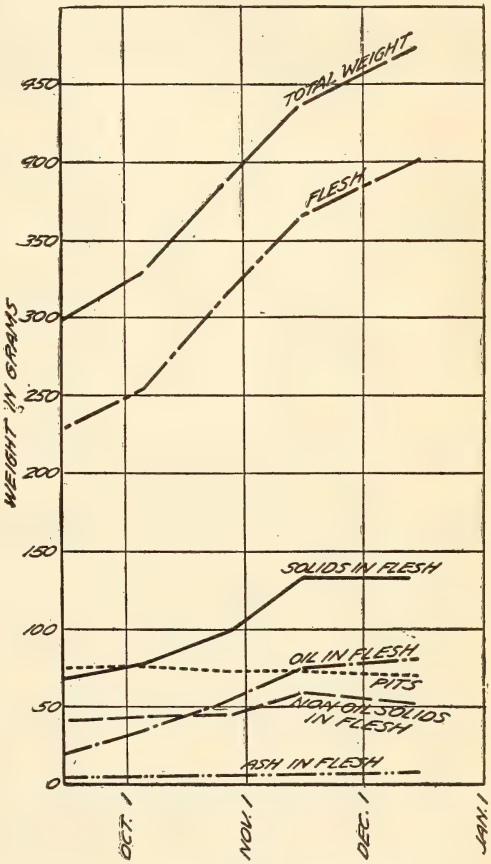


FIG. 2.—Changes in weight of 100 Mission olives occurring during ripening in 1915.

Summarizing these observations, during the ripening, after the pit is formed, the pits remain practically constant while the growth in the flesh continues, and the only constituent of the flesh which increases noticeably, aside from water, is the oil. It thus appears that the amount of oil in the flesh must be the best index of maturity. The same general changes were observed for other trees and other varieties. As the season progressed the olives were found to increase in size, the percentage of pits to decrease, and the oil in the flesh to increase at first rapidly and then more slowly. The protein and ash figures were not significant. A number of minor abnormalities were apparent in the figures obtained. Sometimes the olives appeared to decrease more or less in size, and again the percentages of oil and

solids in the flesh declined somewhat. There are several possible explanations for these abnormalities. One is the difficulty experienced in securing representative tree samples at the later periods, from the middle of November on, due to the picking of part of the fruit on the tree (p. 8). Also, when the fruit is struck by a dry north wind it partially shrivels up, which causes a decrease in its weight and an increase in the percentage of the pit, as well as an abnormal increase in the percentage of the oil and solids in the flesh, which, however, drops back when the fruit plumps out again. This actually happened to some of the samples taken in the middle of November, 1915. Another cause is the irrigation of the trees late in the season, as a result of which the fruit increases in size and gains water in the flesh, which produces a slight drop in the percentage of oil and solids in the flesh. It is, however, not impossible that under certain conditions the absolute amount of oil may actually decrease slightly, as noted by Hartwich and Uhlmann and De Luca.

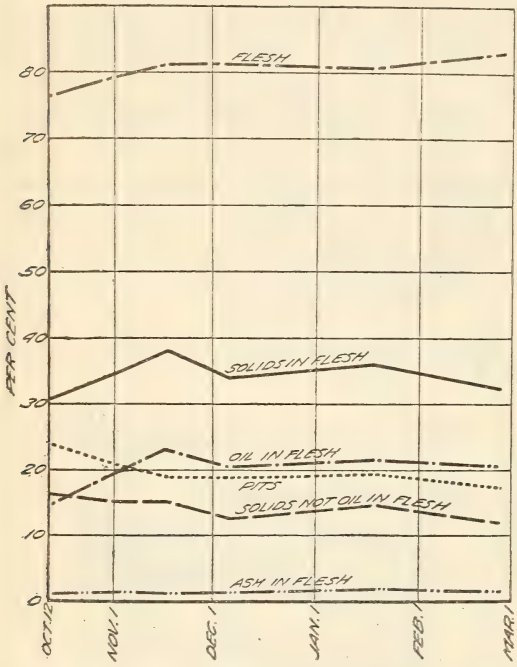


FIG. 3.—Changes in percentage composition of Mission olives occurring during ripening in 1916.

A study of the color changes shows that the olives, which are green in September, begin to color up late in October and in November. Some of the olives may still show a green color in December and January. Calculations of the analyses of the fruit flesh to the moisture-free basis indicated that the percentages of protein and ash decrease somewhat, though not markedly. The oil, of course, increases greatly, approximating in the ripe fruit 60 per cent of the dry substance in the flesh. It was hoped that this might be a valuable factor in judging maturity, but its value is limited, first, because the percentage of oil in the moist flesh is nearly as good an index, and, secondly, because in pickling olives the oil in the flesh on the dry basis increases markedly (p. 20).

Since the percentage of oil in the flesh appears to be the most valuable index of maturity, the data bearing on this subject have been represented graphically for the different varieties of olives in figures 5 to 10. Each curve represents the mean of all the trees sampled in a single grove. In figure 5, representing Missions of 1915, northern district, the rapid increase of oil seems to have ended by the middle of November, at which time the fruit could fairly be said to be mature. The poorest of the groves shown had at least 17 per cent of oil in the flesh at that time. Turning to figure 6, Missions of 1916, a great variation is seen. Some of the groves do not merit much consideration. In Grove H, which is in an exposed situation on the coast near Carpenteria, the olives matured very late and never attained the usual oil content for that variety. Grove Fi, which is near by, is more protected. Grove I was very poorly cared for, with trees in bad condition, and is decidedly not normal. Grove S, near Los Angeles, appeared to have attained its maximum oil content on November 13. Although its oil content was much lower than was that of many other groves, this grove was healthy, flourishing, and scientifically cared for. Excluding from con-

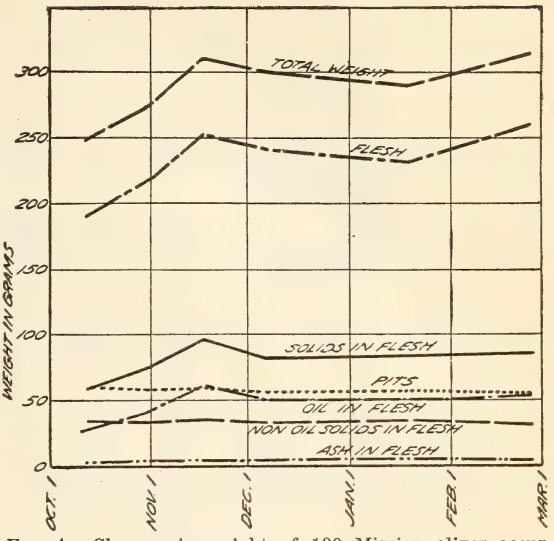


FIG. 4.—Changes in weight of 100 Mission olives occurring during ripening in 1916.

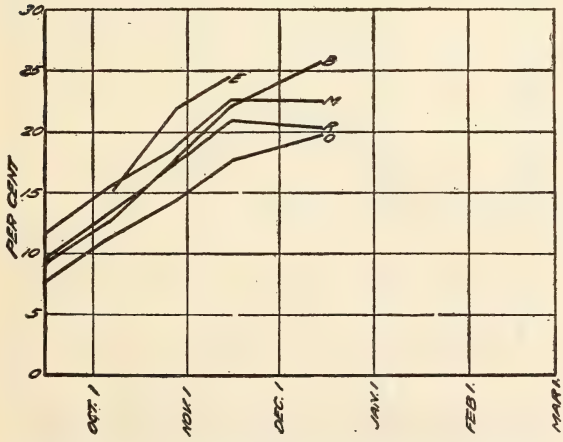


FIG. 5.—Percentage increase in oil content of fruit flesh of Mission olives taken from various groves in 1915.

sideration Groves H and I, and also probably Fi, none of which is normal, it would seem that the fruit which is poorer in oil may be considered fully mature by November 15, with a minimum of something over 17 per cent of oil in the flesh. From the data now at hand it appears, then, that 17 per cent of oil in the flesh may be taken as a tentative minimum standard for maturity in the case of Mission olives.

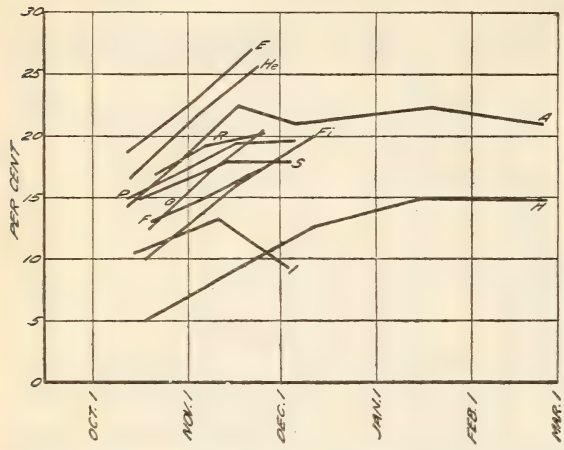


FIG. 6.—Percentage increase in oil content of fruit flesh of Mission olives from various groves in 1916.

The development of the Manzanillo variety is shown in figure 7, in which but few groves are represented, as this olive is not as important as the Mission. The fruit in Grove B appeared subnormal, since it was practically too small to pickle. Compared to the Manzanillos described in Table 2, it seems not unlikely that these crops of 1915 and 1916 may have been unusually low in oil. Analyses in the literature,[1] however, show that the oil in the flesh of this variety averages 2 or 3 per cent less than in the Mission. From the diagram in figure 7 it appears that 15 per cent of oil in the flesh may be taken as a tentative minimum standard for maturity.

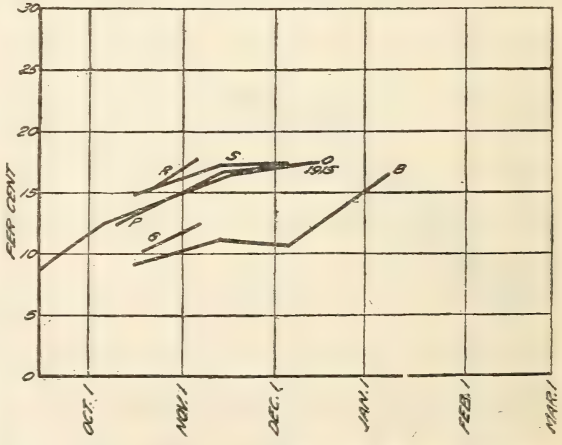


FIG. 7.—Percentage increase in oil content in fruit flesh of Manzanillo olives taken from various groves in 1916.

Of the Sevillano and Ascolano olives represented in figures 8 and 9, it may be said that these are newer varieties, and constitute but a very small percentage of the crop. Few analyses are available on them. Since they become extremely soft when fully mature, they must be picked when in a comparatively

[1] Rept. of Work of Agr. Exp. Sta., Univ. Calif., 1898–1901, pp. 263–307.

immature state, in order to secure a fruit with firm flesh. These varieties, especially the Sevillano, are inferior in flavor, due probably to the lack of oil as pickled, but bring a large price on account of their extraordinary size. When pickled by the California method, they may be said to differ from a green pickled olive in that they are black and do not have the piquant flavor of the green pickle. Considering these facts, it seems impracticable to attempt to set any maturity standard for these olives.

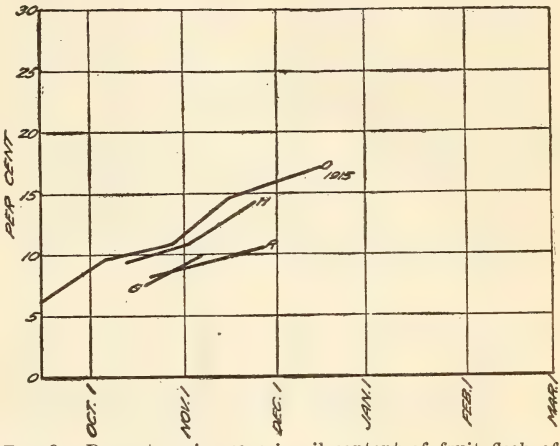


FIG. 8.—Percentage increase in oil content of fruit flesh of Sevillano olives taken from various groves in 1916.

Properly speaking, the Nevadillo olive, one grove of which is represented in figure 10, is an oil olive, although it is sometimes pickled. The curve in this diagram, as well as recorded analyses, indicate that it could easily meet any minimum oil standard set for the Mission olive.

As a matter of interest and for comparison with the data just given, a number of averages for olive varieties,[1] without reference to maturity, are given in Table 4.

TABLE 4.—*Composition of olives of several varieties.*

Variety.	Number samples examined.	Number olives per pound.	Pit.	Oil in flesh.
			Per cent.	*Per cent.*
Mission	112	111.6	17.2	22.51
Manzanillo	38	106.6	14.7	19.73
Nevadillo	57	157.3	17.3	22.92
Ascolano[1]	5	60.6	12.0	18.45
Sevillano[1]	2	36.2	14.5	20.19
Columbella	25	114.6	16.6	19.54

[1] The Ascolano and Sevillano samples must have been quite ripe.

RESULTS OF EXAMINATION OF PICKLED OLIVES.

In 1914, and again in 1916, arrangements were made with a number of picklers for the sampling of marked vats of olives, as received, or before pickling began, and at the end of the process. Much practical information was gathered during this work, in which the picklers, with one exception, cooperated cordially. The data from

[1] Rept. of Work of Agr. Exp. Sta., Univ. Calif., 1898–1901.

these experiments are summarized in Table 5. Briefly, the results of these experiments showed that pickling has little effect on the size of the olives or on the percentage of pits. The solids in the flesh, starting with fresh olives, fall 5 or 6 per cent. The oil in the flesh undergoes little change, or decreases very slightly. Some notable exceptions to this rule were undoubtedly due, for the most part, to poor sampling. The addition of salt raises the ash content, but the original salt-free ash is partially leached out. The solids not oil show a notable decrease from the fresh fruit, dropping 5 or 6 per cent, which accounts for a corresponding diminution in total solids. This loss consists mostly of soluble carbohydrates and probably the bitter glucoside. Up to nearly 4.5 per cent reducing sugar, calculated as dextrose, which disappears entirely during pickling, was found in fresh, ripe olives. The protein, which was determined in a few experiments, did not suffer notable change. Because of the loss of solids not oil, the percentage of oil in the flesh on the dry basis is largely increased, rising from about 60 per cent for fresh, ripe fruit to a value 10 or 12 per cent higher after pickling. In some cases the fact that the loss in solids and gain in oil on the dry basis are less is due to the fact that the fruit had been previously shipped or held in brine, causing a loss of solids not oil before the experiment was begun.

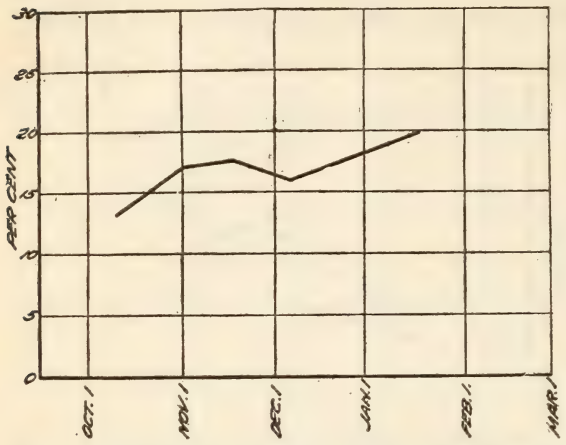


FIG. 9.—Percentage increase in oil content of fruit flesh of Ascolano olives taken from one grove in 1916.

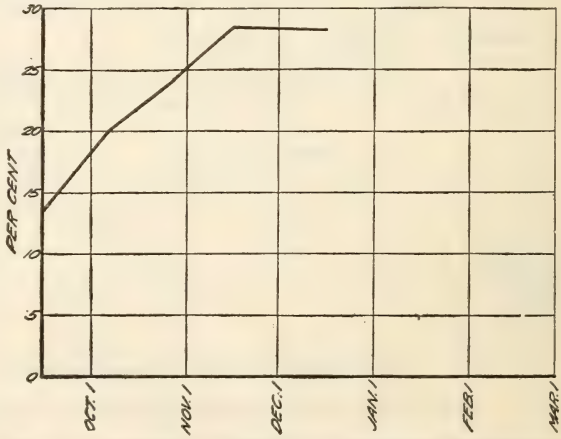


FIG. 10.—Percentage increase in oil content of fruit flesh of Nevadillo olives taken from one grove in 1915.

TABLE 5.—*Effect of pickling on composition of olives.*

Experiment No.	Source and grade.	Date of sampling.		Number per pound		Pits.		Fruit flesh.										Ether extract in fruit flesh (dry basis).		Description and remarks.	
								Solids.		Ether extract.		Ash.		Salt-free ash.		Solids, not oil.					
		Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.
	MISSION OLIVES.																				
						P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.		
1	Packer A, Sylmar. "Extra fancy."	Nov. 13	Dec. 14	69	69	13.8	14.7	28.80	22.68	17.42	17.47	1.31	1.82	1.07	0.49	11.38	5.21	60.49	77.03	Held in brine 4 days. Color: ⅓, yellow to red; ⅔, red to purple.	Little salt; firm texture; freestone; fair flavor; dark brown, half with purplish bloom.
2	Packer B, Los Angeles. "Extra fancy."	Nov. 14	Dec. 20	93	95	15.0	15.0	32.20	27.84	20.14	21.38	1.00	2.30	....	.56	12.06	6.46	62.55	76.80	Held in water 8 days. Well colored; riper than usually pickled.	Some light brown; rest, nearly black. No bloom. Very tough.
3	Packer B, Los Angeles. "Standard."	Dec. 13	Jan. 8,7	150	144	18.7	18.7	40.17	26.86	24.15	20.89	1.80	2.03	1.64	.55	16.02	5.97	60.15	77.78	Fresh from trees. Color: ⅓, green to yellow; ⅔, yellow to red.	Light to dark brown. Rather soft; fair flavor.
4	Packer C., Bloomington.	Nov. 16	Dec. 8	94	94	14.2	14.7	32.87	27.36	20.82	20.54	1.47	2.61	1.19	.72	12.05	6.82	63.34	75.08	Picked Nov. 11, 1916, Lindsay, Calif. Shipped in brine containing ⅓ pound caustic soda, 1½ pounds salt to 50 gallons. Color: ½, green to red; ½, red to purple.	Color uneven; partly reddish brown; partly with purplish bloom.
5	.....do.....	...do.....	...do.....	101	100	15.0	15.8	32.01	26.73	19.94	19.59	1.40	2.57	1.14	.75	12.07	7.14	62.29	73.29	Same as Exp. 4. Color: ⅔, green to yellow; ⅓, yellow to red.	Brown to nearly black, little or no purple bloom. Texture and flavor fair.
6	Packer D, Los Angeles.	Nov. 29	Jan.17,7	123	121	15.6	16.3	29.16	23.70	17.77	17.55	1.20	2.01	....	.41	11.89	6.15	60.94	74.05	Apparently shipped in water. Color: ⅔, green to yellow; ⅓, yellow to red.	Dark brown; some purplish bloom. Fair flavor.
7	Packer E, Oroville.	Dec. 8,4	Jan. 6,5	110	115	17.7	17.8	29.5	27.9	20.07	19.90	.97	3.07	....	.70	9.43	8.0	68.2	71.3	Held several days in very weak caustic soda. Color quite uniformly green tinges of red.	Color varies from black to yellow, with many brown. Very firm on pit.
8	.....do.....	...do.....	...do.....	72	76	13.7	14.4	31.8	29.0	21.40	21.65	1.21	3.38	....	.64	10.40	7.35	67.3	74.7	Color uniformly black. Held several days in very weak caustic soda.	Color varies from yellow or tan to purplish black. Appearance similar to Exp. 7, except free on pit.

TABLE 5.—*Effect of pickling on composition of olives*—Continued.

Experiment No.	Source and grade.	Date of sampling.		Number per pound		Pits.		Fruit flesh.										Ether extract in fruit flesh (dry basis).		Description and remarks.	
								Solids.		Ether extract.		Ash.		Salt-free ash.		Solids, not oil.					
		Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.
						P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.	P.c.		
9	Packer F, Oroville.	Dec. 9, 4	Jan. 9, 5	79	98	15.7	16.8	38.6	30.6	22.38	23.65	1.65	3.06	....	0.88	16.22	6.95	58.0	77.3	Color, fairly uniform red. Held in water several days.	Chocolate to purple black.
	Average.....	.....	.....	99	101	15.5	16.0	32.79	26.96	20.45	20.29	1.33	2.54	....	.63	12.39	6.67	62.58	75.26		
	MANZANILLO OLIVES.																				
10	Packer G, San Diego. Size No. 2.	Nov. 2	Nov. 17	78	74	11.9	10.9	25.44	18.81	14.23	12.65	1.82	2.86	0.75	.57	11.11	6.16	56.05	67.25	Held in brine 1 month. Color: ½, yellow to red; ½, green to yellow; red olives show brownish tinge.	Purplish bloom. Clingstone; leathery texture; quite salty; poor flavor.
11	Packer H, Fresno. "Special."	Nov. 6	Nov. 27	71	67	10.9	11.0	27.57	20.48	16.67	14.14	1.74	2.39	1.37	.57	10.90	6.34	60.47	69.05	Color: ⅓, green to yellow; ⅔, yellow to red. Held in brine 10 days.	Purplish bloom. Clingstone; leathery texture; quite salty.
12	Packer H, Fresno. Size No. 1.	...do.....	...do.....	65	64	9.9	9.8	26.91	19.84	15.82	13.56	1.13	2.95	.91	.45	11.09	6.28	58.79	68.35	Color: ½, green to yellow; ½, yellow to red. Held in brine 10 days.	Purplish bloom. Fairly freestone; slightly leathery; salty flavor.
13	Packer I, Porterville. Size No. 1.	Nov. 8	Nov. 28	64	62	10.6	10.3	26.56	21.76	15.91	14.79	.96	2.87	....	.59	10.65	6.97	59.90	67.97	Color: ½, green to red; ½, red. Held in water 1 week.	Brown with purplish bloom. Clingstone; flavor poor; texture variable.
14	Packer J, Pacoima.	Nov. 13	Jan. 9, 7	75	81	9.8	10.9	18.70	18.82	11.42	12.79	.84	2.58	....	.56	7.28	6.03	61.07	67.96	Color: ⅓, green to yellow; ⅔, yellow to red. Probably held in water.	Half dark brown, ½ with purplish bloom. Texture good; flavor poor.
15	Packer B, Los Angeles.	Nov. 14	Dec. 13	77	72	10.5	10.5	20.73	18.39	12.51	13.00	.88	2.62	....	.51	8.22	5.39	60.35	70.69	Color: ⅔, green to yellow; ⅓, yellow to red. Held in water 2 days.	Brown to purplish brown. Firm texture; good flavor.
16	Packer C, Bloomington.	Nov. 16	Dec. 8	98	92	11.2	11.3	24.70	21.65	15.71	15.51	1.12	2.19	0.86	.68	8.99	6.14	63.60	71.64	Picked Nov. 11, 1916, Lindsay, Calif. Shipped same as Exp. 4. Color: ½, green to yellow; ½, yellow to red.	Color irregular, partly reddish brown, ⅓ with purplish bloom.

17	Packer K, San Diego.	Nov. 17	Dec. 20	69	69	10.7	10.9	25.50	20.94	14.85	14.61	2.83	3.02	.77	.46	10.65	6.33	58.23	69.78	Picked Oct. 27, 1916, Fresno, Calif. Shipped in brine, ½ pound salt per gallon. Color: Green, with red tinges when picked.	Half brown, ½ with purplish bloom. Soft texture.
	Average			74	73	10.7	10.7	24.51	20.08	14.64	13.88	1.41	2.68	....	.55	9.86	6.20	59.81	69.08		
	ASCOLANO OLIVES.																				
18	Packer C, Bloomington.	Dec. 8	Jan. 15,7	60	56	11.6	11.2	22.78	19.85	13.66	13.67	1.13	1.66	1.03	.58	9.12	6.18	59.96	68.87	From Oroville district. Held in weak brine 1 month. Color probably green.	Some brown; most with purplish bloom. Texture very firm.
	SEVILLANO OLIVES.																				
19	Packer C, Bloomington.	...do.....	...do.....	41	36	12.5	11.5	17.79	15.09	10.93	10.27	.93	1.32	.78	.65	6.86	4.82	61.44	68.06	Color: ¾, green to yellow; ¼, yellow to red. Held in weak brine.	Dark brown. Texture very soft; flavor very poor.

The color changes are remarkable and important. Green or yellow colored olives, by suitable manipulation, emerged from the process with a uniform, pleasing black color. In fact, green-colored olives have a tendency to yield a blacker final product than purple olives. The best color, however, is probably developed in olives showing some red at first. Purple olives tend to lose their color and come out brown or even tan. The black color is developed by aeration accompanying alkali treatment, and there seems reason to suspect that the final black is due not to the original pigment substance but to something developed during the pickling. The original colors turn a dirty brown or tan in the first caustic liquor. One of the factories has experimented with the addition of ferrous sulphate to the wash waters, with the idea of fixing the color. The pits of the olives so treated have a marked black color. The results of this treatment have been unsatisfactory.

SUMMARY.

The results of the investigation here reported indicate that the best index of maturity for olives, both fresh and pickled, is the percentage of oil in the fruit flesh. Allowance, of course, must be made for variations due to the variety of the olives and the locality in which they are grown. A minimum oil content of 17 per cent in the flesh is offered as a tentative standard of maturity for Mission olives and other common varieties, except the Manzanillo, Ascolano, and Sevillano. A minimum oil content of 15 per cent is recommended as a tentative standard for Manzanillo olives. No standards for maturity are recommended for the large-fruited olives, Ascolano and Sevillano, which must be gathered when relatively immature. These olives, however, should not be sold under the designation "ripe."

Because of the great variations noted in the composition of olives of the same variety grown in different localities, it probably will never be practicable to set definite and hard fixed minima for oil in mature olives, and the proposed standards must be applied with caution.

It was found that some of the abuses, the report of which led to this investigation, did exist, immature olives having often been pickled and colored to simulate pickled ripe olives. The data here given will make possible the detection of gross frauds of this nature.

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